

737/CFM56-7 AIRCRAFT ENGINE SYSTEMS

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ABSTRACT

The configuration of the propulsion system engine externals must meet many airplane requirements such as cost, thrust, weight, range and systems power extraction. On the 737-700 several program requirements also played a major role in the development of the engine externals. These program goals were increased range, same cost as a 1994 737-300, 15% reduction in maintenance costs from the 737-300, and a propulsion package that appeared as if it was designed by one company.. This presentation will show how these requirements shaped the design of the engine externals for the 737-700/CFM56-7B.

Engine Installation

multiple W-shock

TOASTER



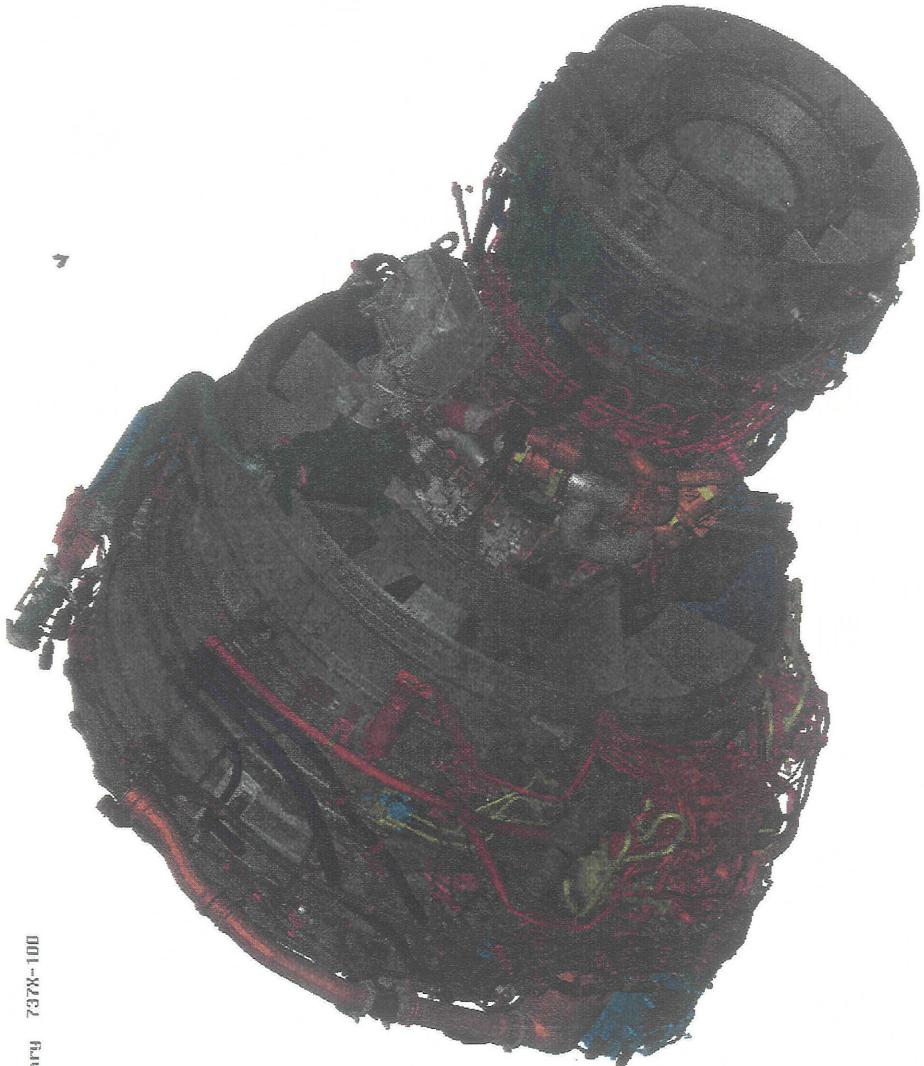
Boeing



Boeing Designed Systems

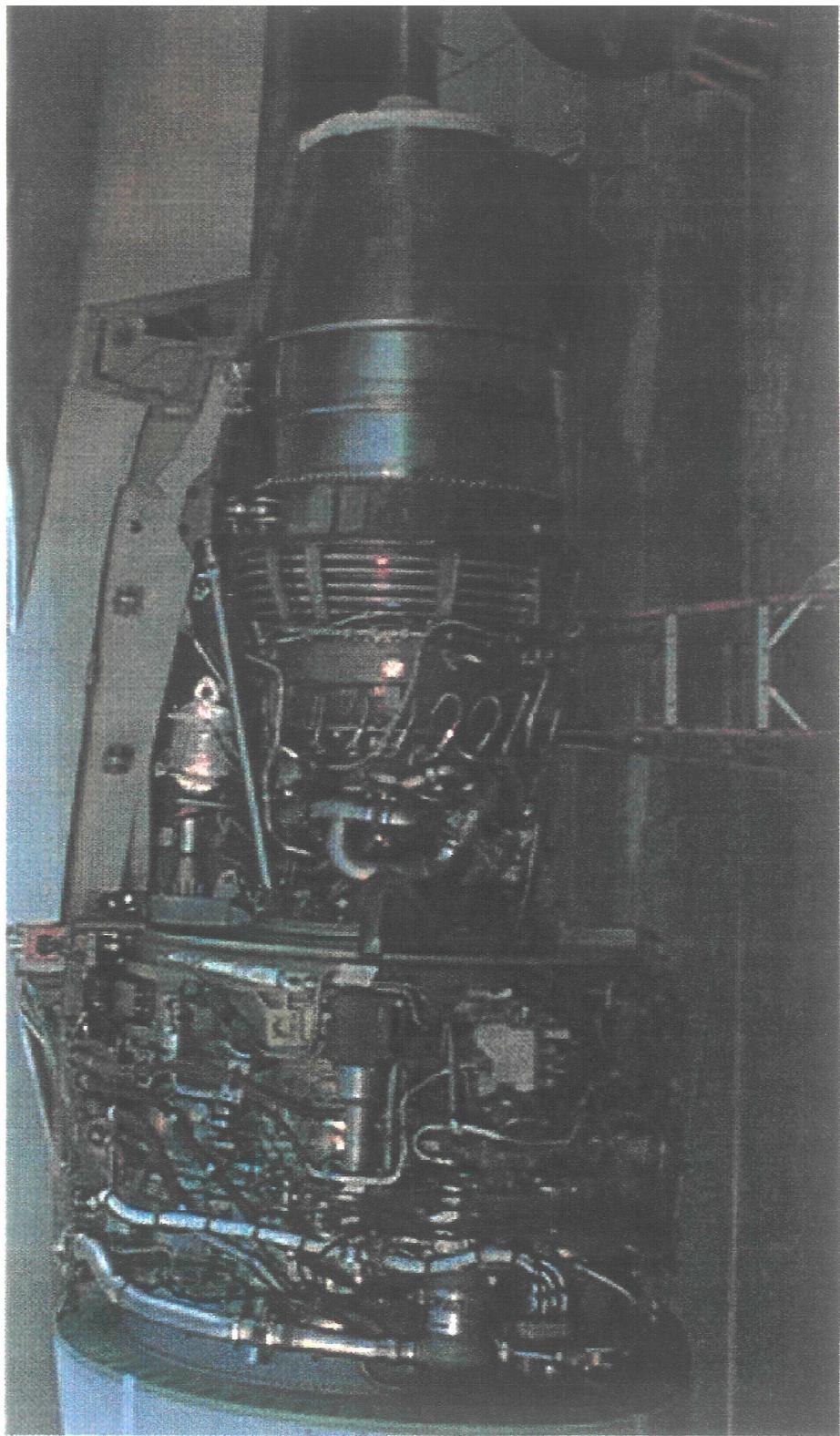
- Pneumatics - ducting, valves, controllers, precooler
- Starting - ducting, valve
- Integrated Drive Generator (IDG) - power feeder cables, cooling
- Cowl Thermal Anti-Ice (CTAI) - ducting, valve, controller
- Fire Protection - fire detectors, drains, extinguishing
- Fuel Line
- Hydraulics - hoses, tubes, case drain filter

CFMII and Boeing

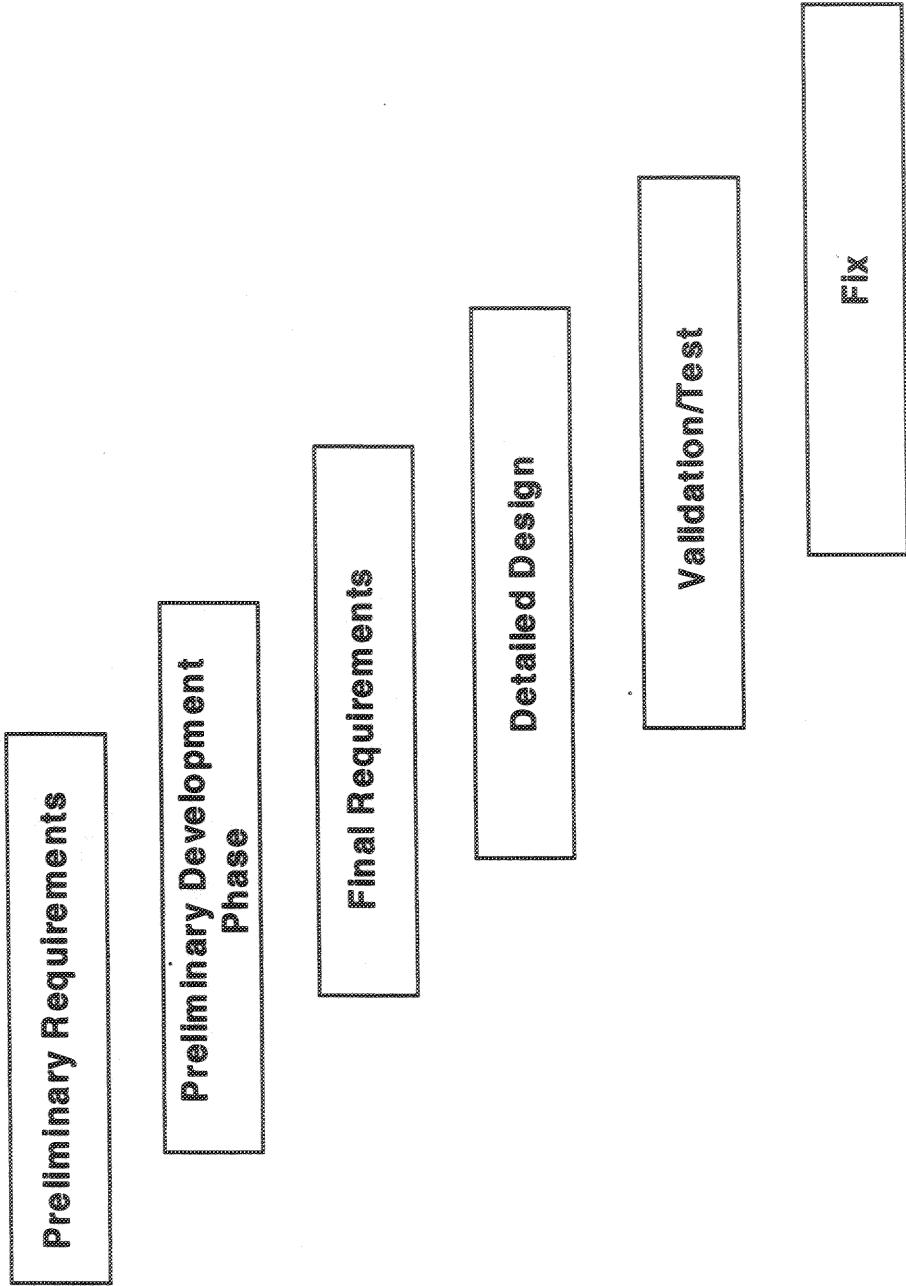


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Engine Without Cowls

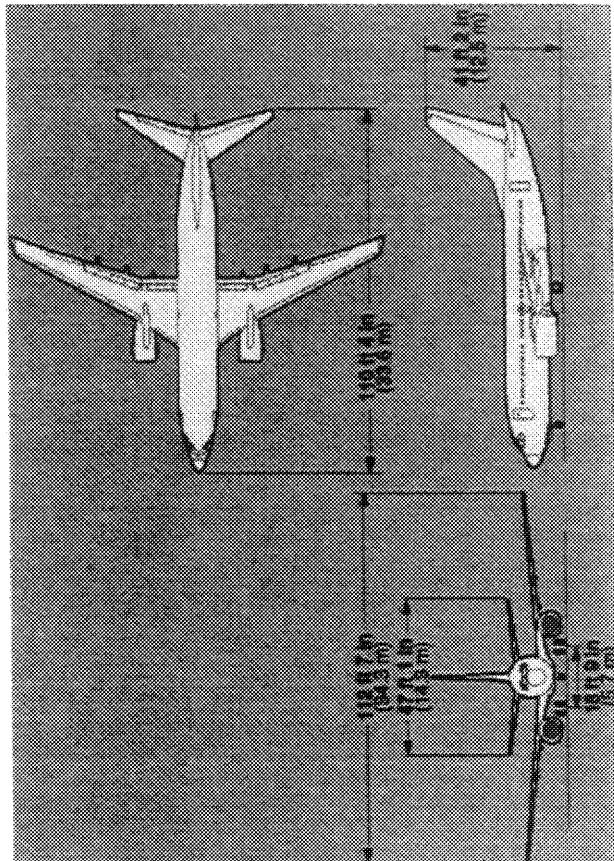
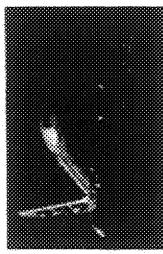
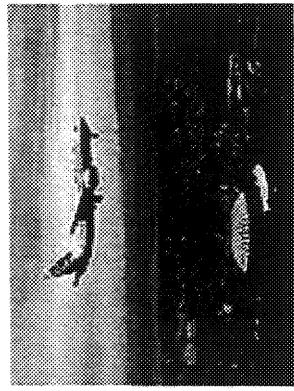
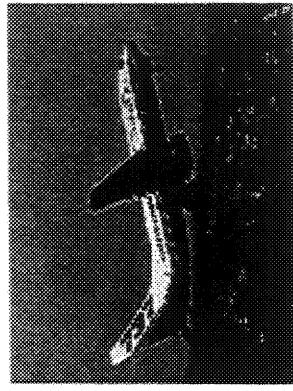


How We Ended Up With This Configuration



AIRPLANE

737-700



737NG AIRPLANE FOCUS

- Past
 - Fly It
 - Higher
 - Farther
 - Faster than competition
 - Boeing's Economics
- Present
 - Emphasize Airline's Economics
 - And Fly It
 - Farther
 - Faster
 - Higher than current 737

737NG ENGINE FOCUS

- Decrease
 - Noise - Stage 3 minus 4 db
 - Fuel Burn - 7.7% lower SFC than CFM56-3C-1
 - Maintenance - 15% less maintenance cost than CFM56-3C-1
 - Cost - same price as today's 737
- Increase
 - Thrust - up to 26,400 lbs
 - Reliability/Time on Wing

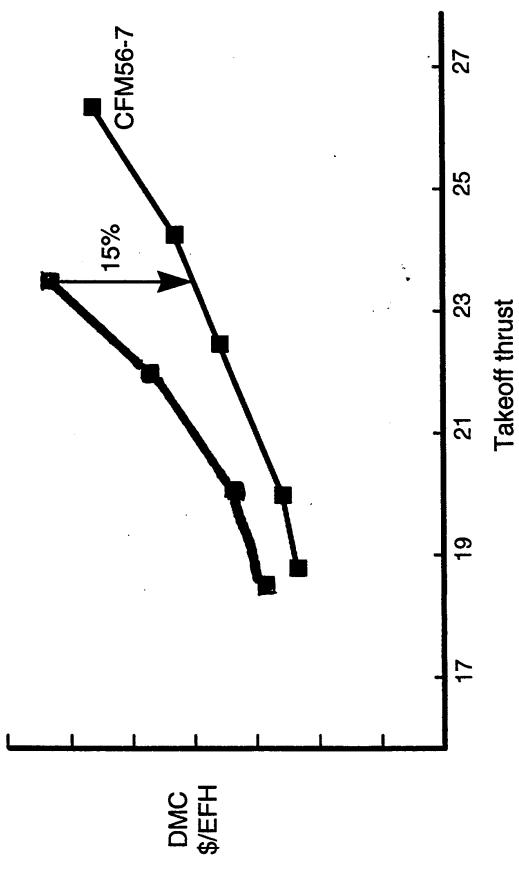
737NG EBU FOCUS

- Decrease
 - Maintenance
 - Fuel Burn (indirectly)
- Minimize weight, cooling air
- Cost
- Recurring and Non-Recurring
- Increase
- Reliability/Time on Wing

* RELIABILITY AND MAINTAINABILITY WERE KEY
DESIGN INFLUENCES

Reduced Maintenance

- 15% Reduction in Total Direct Maintenance Cost from 737-300
- Get Customer Input Early
 - Ease of component removal was a primary focus
 - Digital verification for all LRU's by design engineers
 - Physical validation by airline mechanics



Improved Reliability

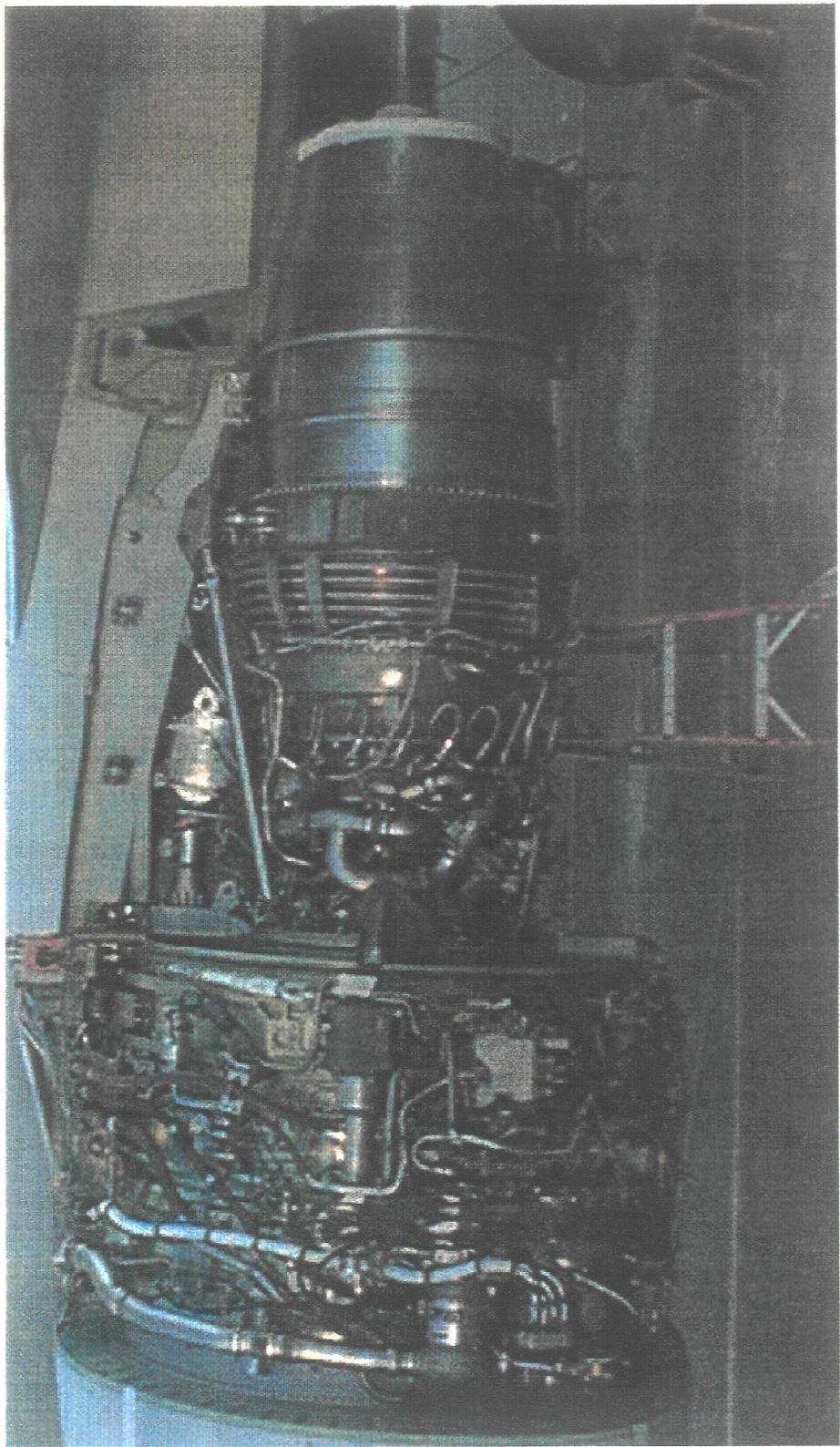
- Use Existing Components if Reliable
 - Bleed Air Valves and Regulators
- Lessons Learned Incorporated From Other Programs
 - CTAI Valve, Starter, IDG, Fire Detectors
- New Technologies Must Be Proven Out
 - Precooler Control Valve
- Extensive Testing to Validate Designs
 - Complete EBU package on all engine tests (**goal**)

INTERNAL EQUIPMENT

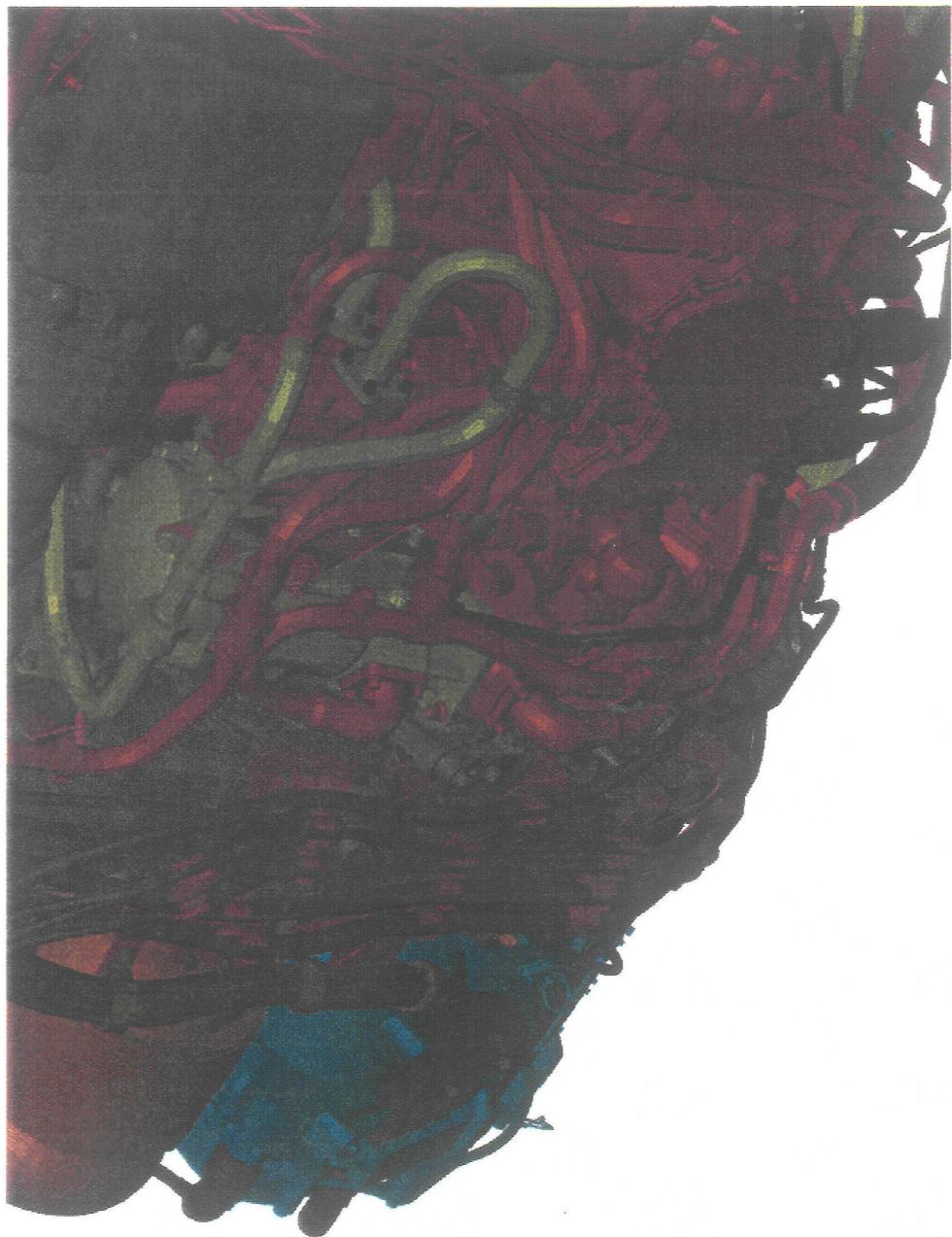
BASIC REQUIREMENTS

- **PERFORM INTENDED FUNCTION**
- **CAN BE INSTALLED ON THE AIRPLANE**
- **BUILDABLE**
- **WITHSTAND INSTALLATION ENVIRONMENT**
 - Vibration
 - Fatigue - Last the Life of the Airplane
 - Temperature
 - Fluid Resistance
- **MEETS FAR'S**

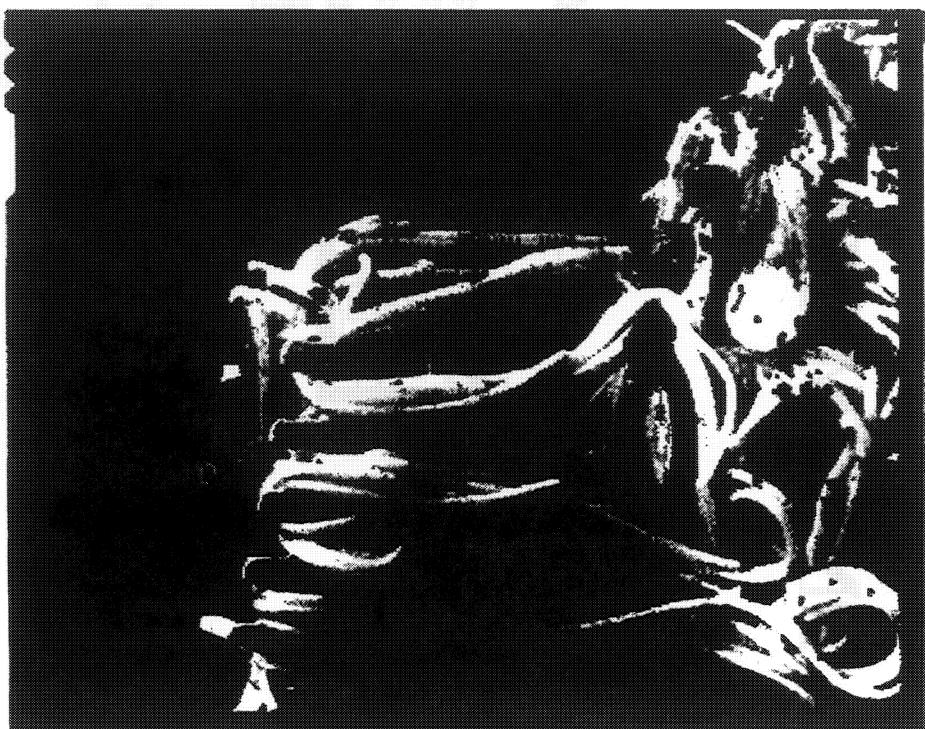
Engine Without Cowls



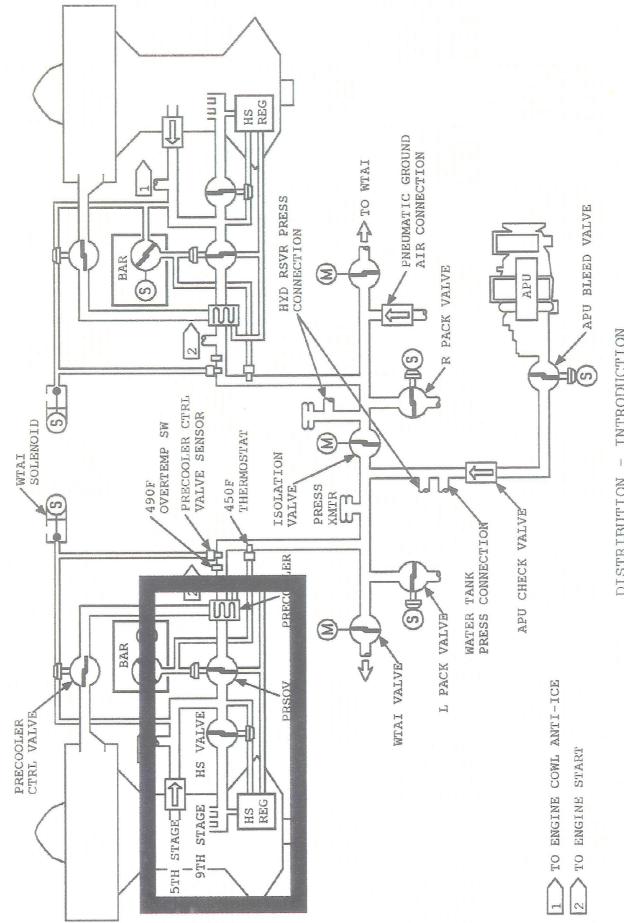
SPAGHETTI



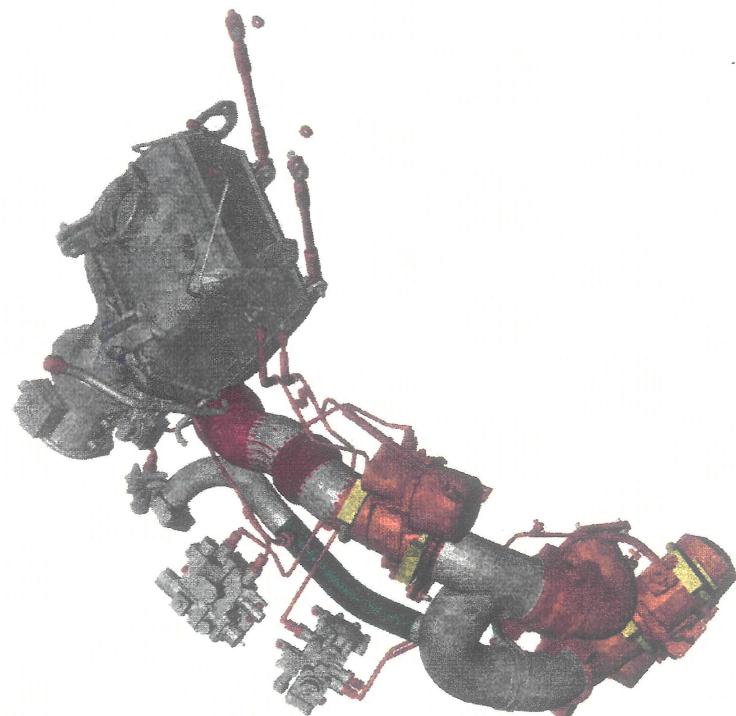
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PNEUMATICS

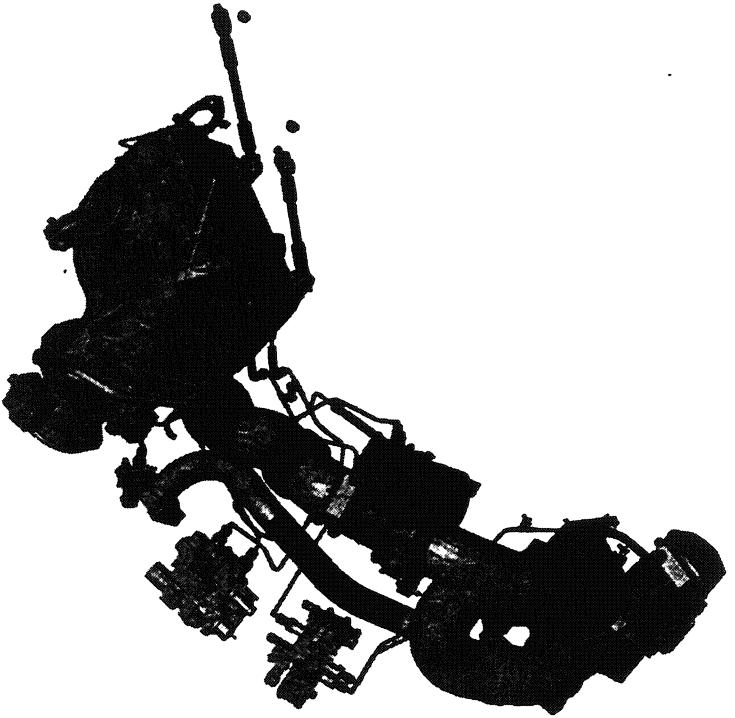


DISTRIBUTION - INTRODUCTION

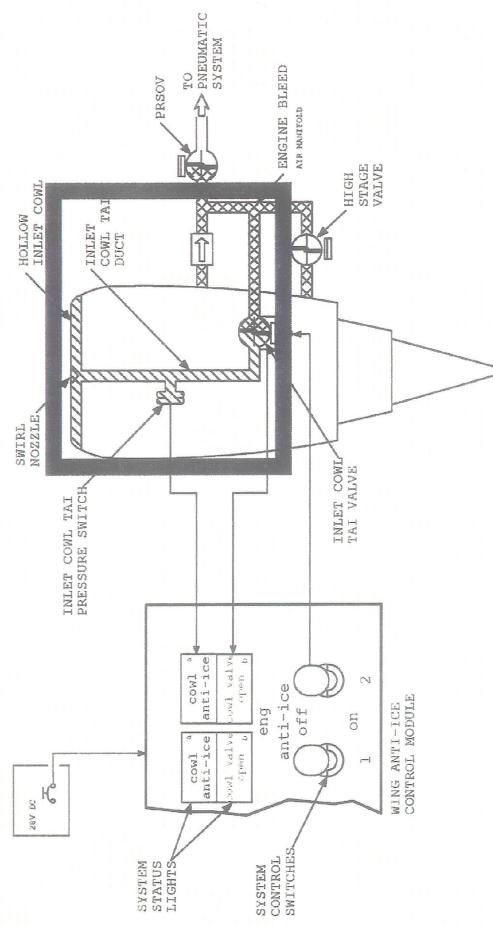


PNEUMATICS

- Responsibilities
 - Ducting
 - Flex Joints
 - Flanges
 - Valve Installation
 - Controller Installation
 - Precooler Installation
- Requirements
 - Pressurize the Airplane
 - Temperature Control
 - Pressure Relief
 - Nacelle Cooling / Engine Case Distortion
 - Equipment Removals
 - Pressure Loss
 - MTBUR



CTAI



INLET COWL ANTI-ICING SYSTEM - INTRODUCTION

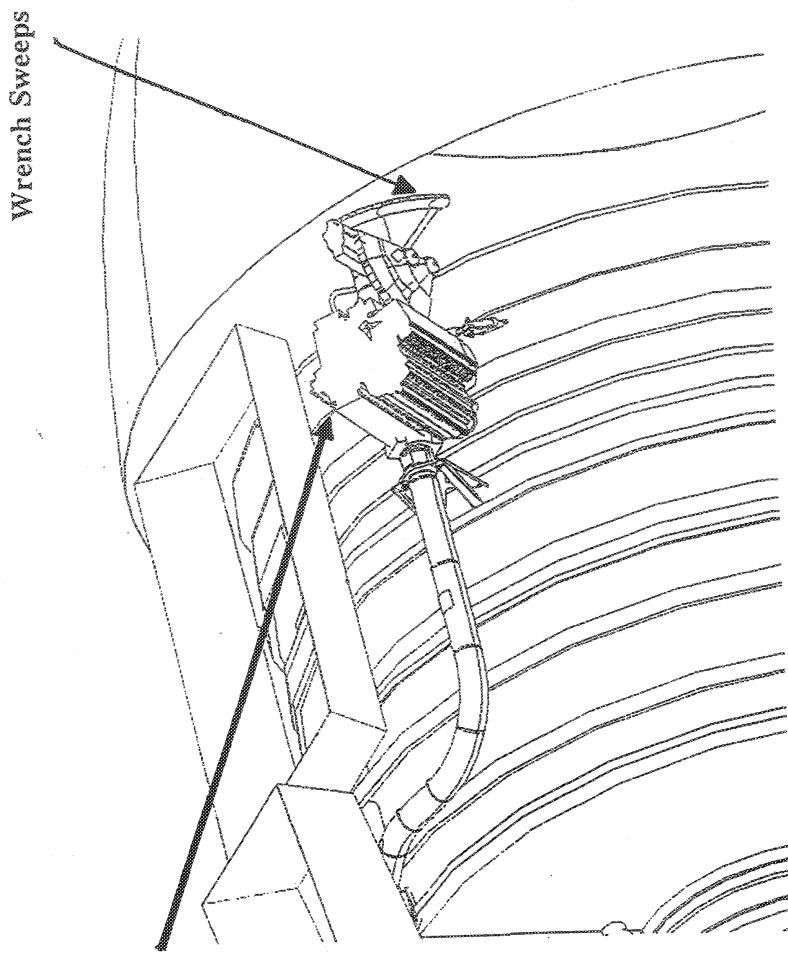
CTAI

- Responsibilities
 - Ducting
 - Flanges
 - Valve
 - Pressure Sensor Installation
- Requirements
 - Anti-Ice Engine Inlet
 - Pressure Drop
 - Heat Rejection into Fan Compartment
 - Valve Removal
 - MTBUR
 - •

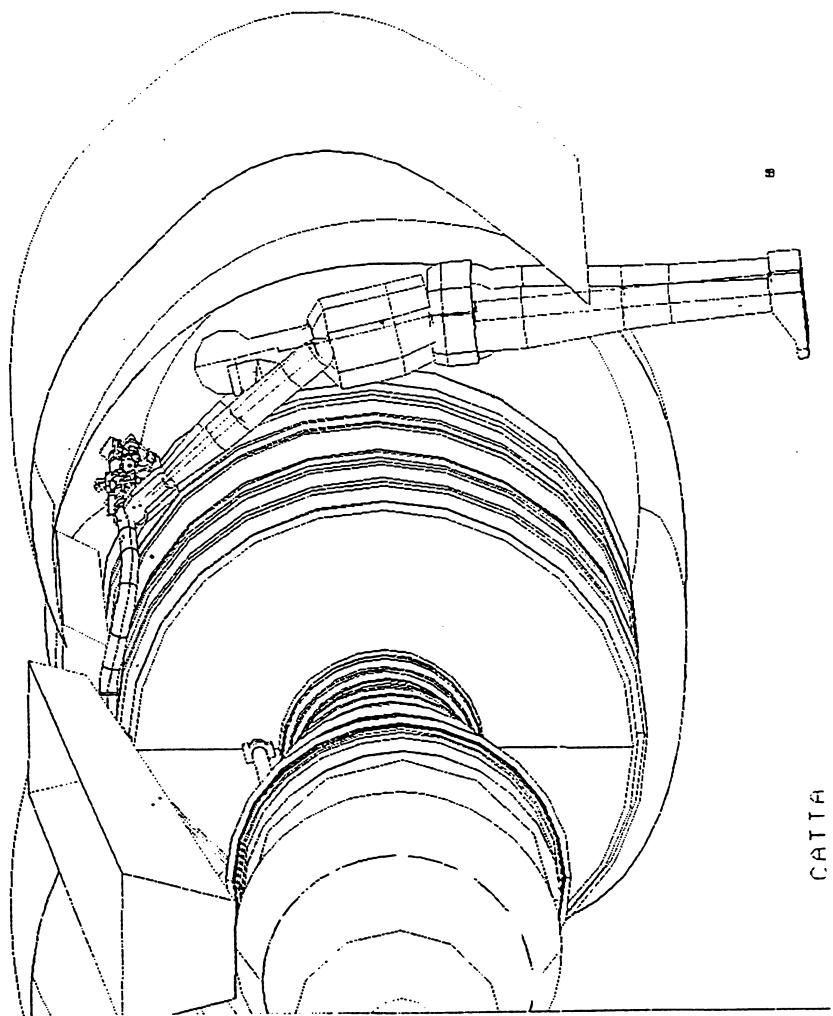


PNEUMATICS MAINTENANCE

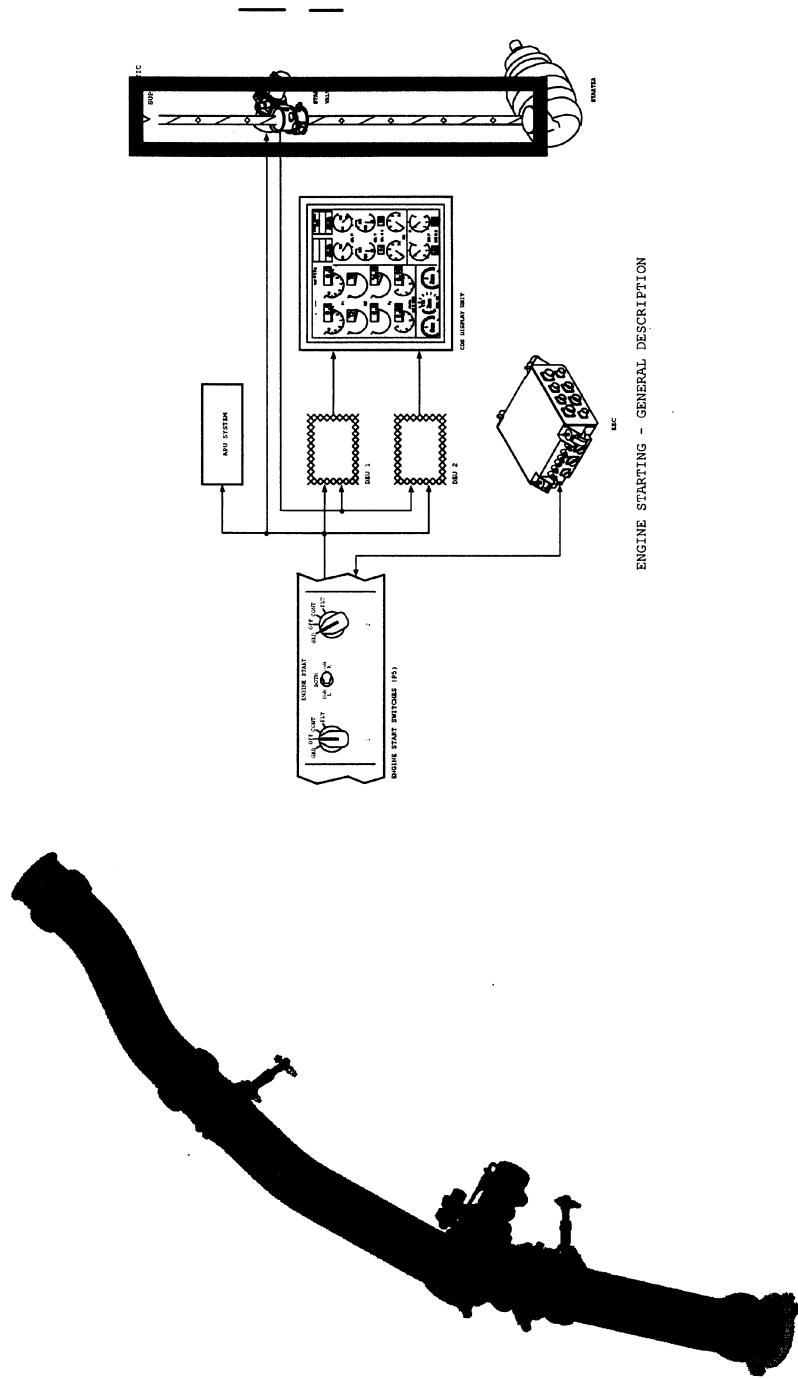
Modeling Removal Path
Swept Volume Stored in CATIA



PNEUMATICS MAINTENANCE



STARTER



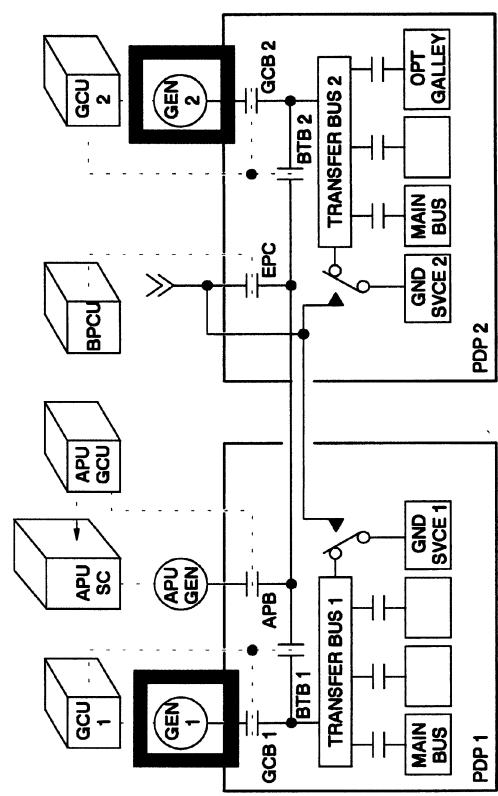
Change identifier in View - Header and Footer

STARTER



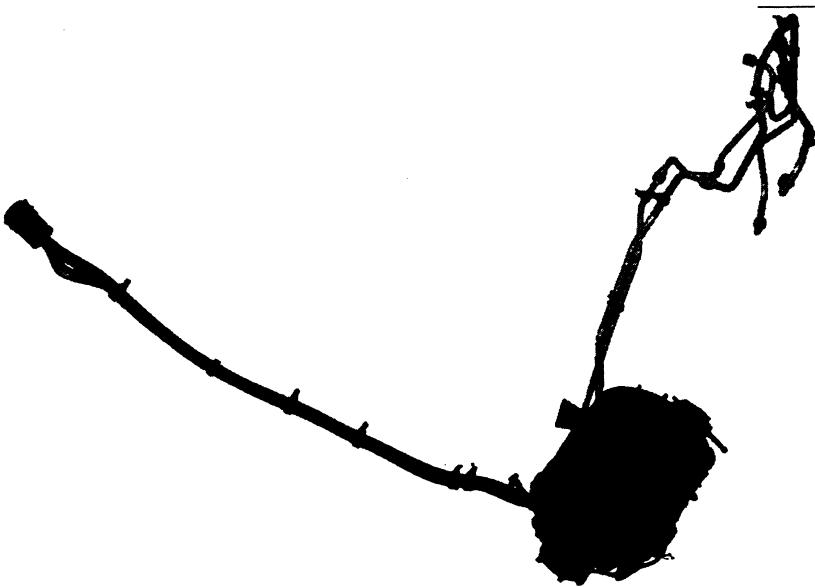
- **Responsibilities**
 - Ducting
 - Flex Joints
 - Flanges
 - Valve Installation
- **Requirements**
 - Supply Air to the Starter
 - MTBUR
 - Valve Removal

IDG



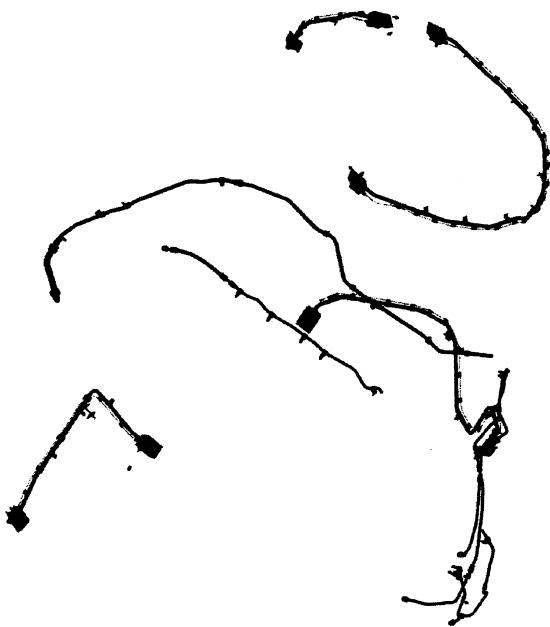
IDG

- Responsibilities
 - Power Feeder
 - Oil Cooling Lines
 - Air/Oil Cooler
 - IDG Installation
- Requirements
 - Engine/Gearbox Deflections
 - Pressure Drop
 - IDG Retention for Blade Out
 - IDG Removal
 - MTBUR
 - Fire Safety

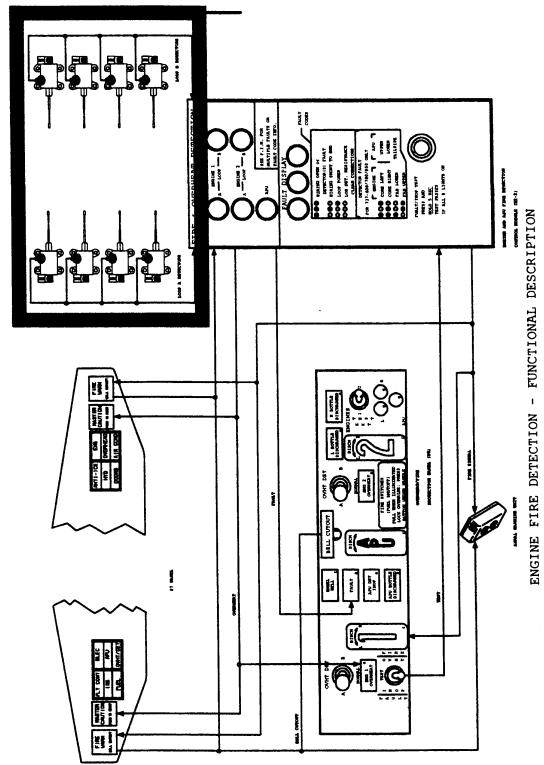


FIRE PROTECTION

- Responsibilities
 - Fire Detectors
 - Fan Case Drains
 - Firex Tubes
- Requirements
 - Down Hill Drains
 - Overheat Detection
 - Fire Detection
 - Fire Detector Removal
 - MTBUR



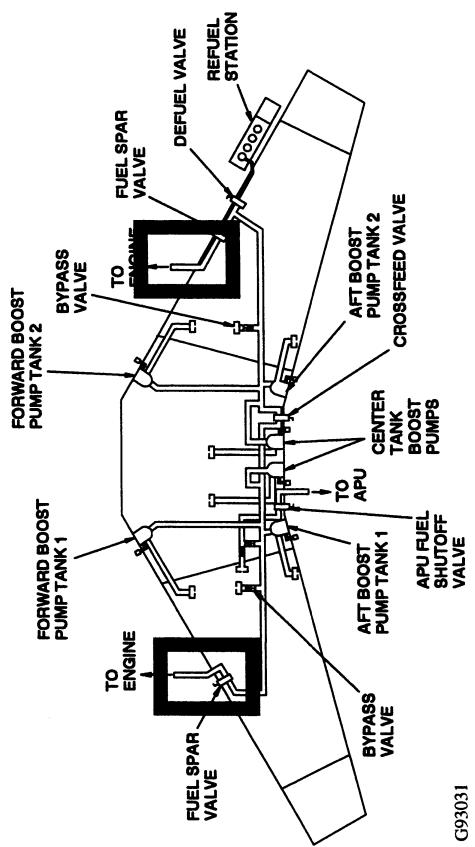
FIRE PROTECTION



ENGINE FIRE DETECTION - FUNCTIONAL DESCRIPTION



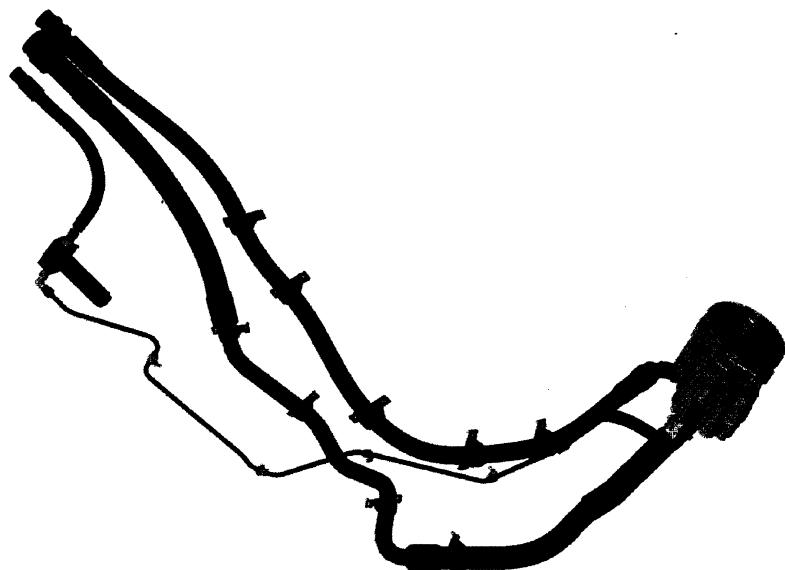
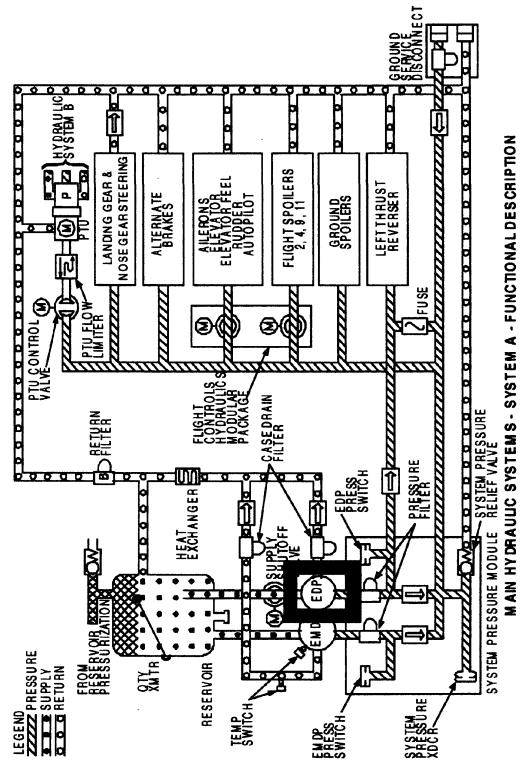
FUEL



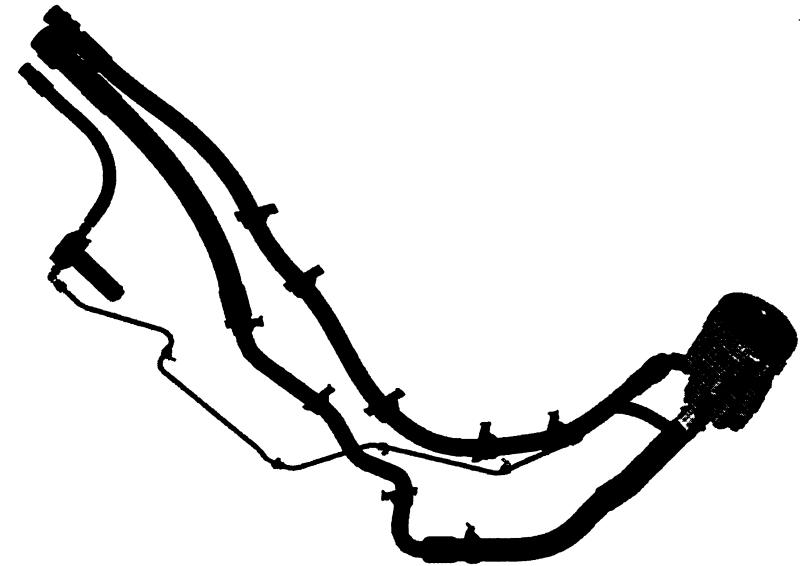
FUEL

- Responsibilities
 - Fuel Hose
- Requirements
 - Strut/Engine Deflections
 - Pressure Drop
 - Fire Safety

Hydraulics



HYDRAULICS



- Responsibilities
 - Hoses
 - Tubes
 - Case Drain Filter Installation
 - Pump Installation
- Requirements
 - Pressure Drop
 - Fire Safety
 - Strut/Engine Deflection
 - Engine/Gearbox Deflection
 - Pump Removal
 - MTBUR

BRACKETS



BRACKETS

- Responsibilities
 - Brackets
- Requirements
 - Retain Systems and Components



NACELLE VENTILATION

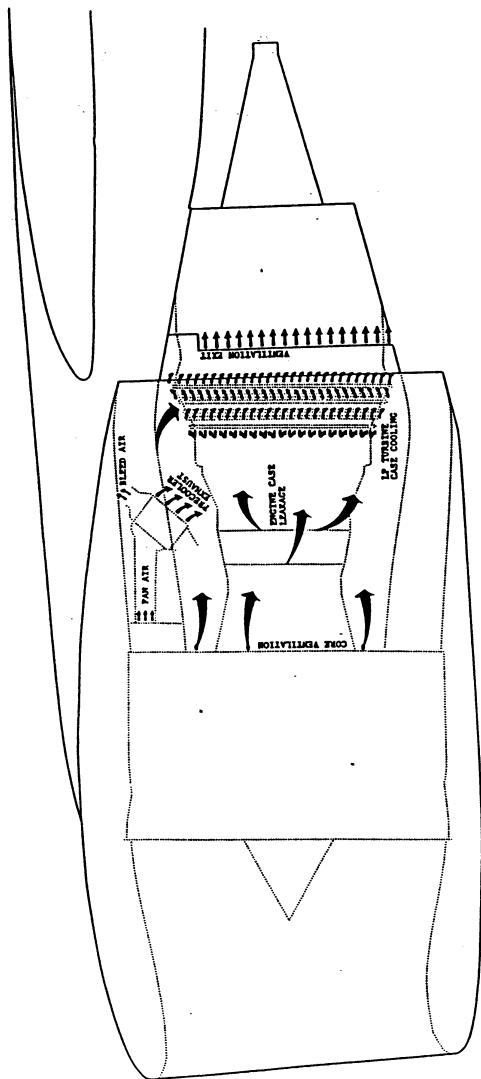
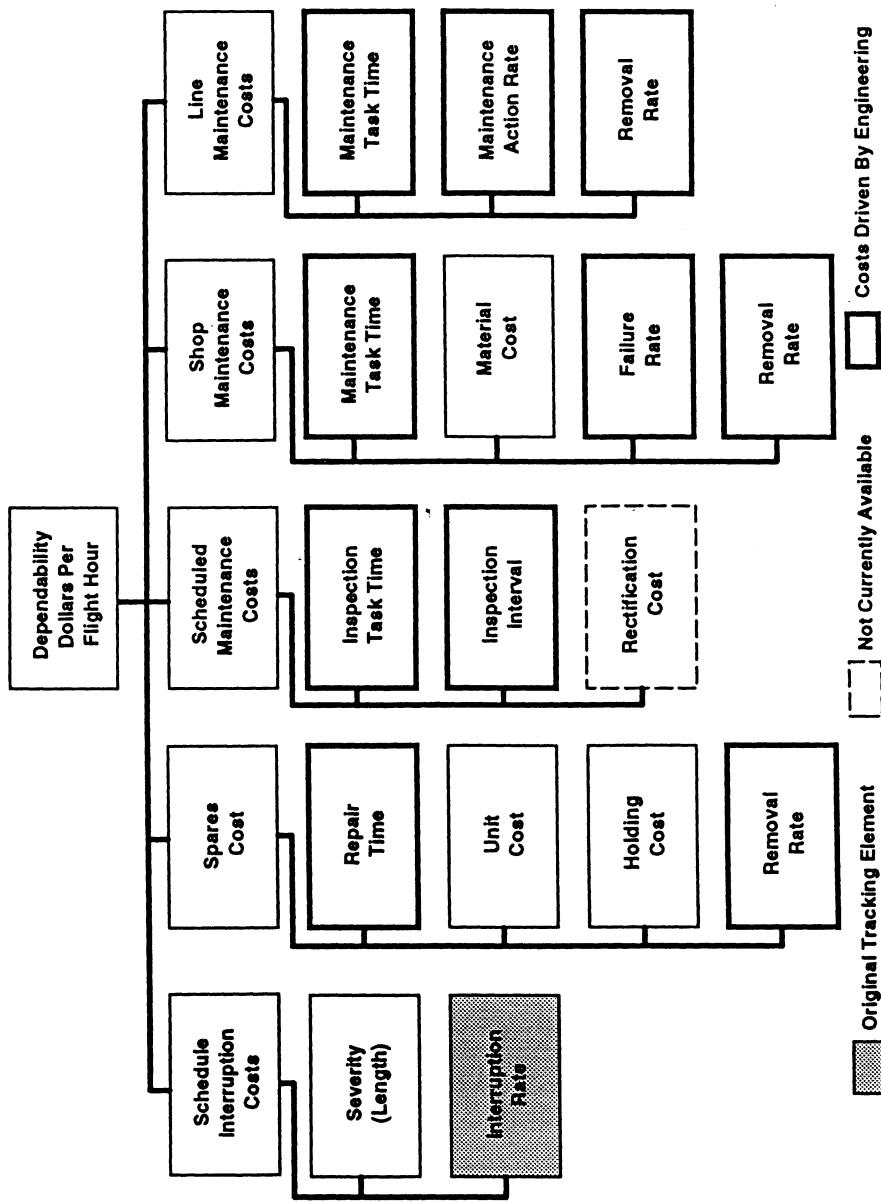


FIGURE 3-9
CORE COMPARTMENT VENTILATION

Dependability

AIRPLANE DEPENDABILITY COST ELEMENTS



Conclusion

- EBU Systems are the Power Source for the Airplane.
- Five Basic Requirements Are the Major Focus.
 - Function
 - Installation
 - Production
 - Environment
 - FAR's
- EBU System is a Small Portion of the Airplane Systems.
- One System can Effect Numerous Systems.
- Each System has Unique Requirements.